DOCUMENT RESUME

ED 361 456 UD 029 468

AUTHOR Johnson, Robert C.
TITLE Providing African-American Students Access to Science and Mathematics. Research Report #2.
INSTITUTION Cleveland State Univ., OH. Urban Child Research Center.
PUB DATE 92
NOTE 44p.
AVAILABLE FROM Urban Child Research Center, Levin College of Urban Affairs, Cleveland State University, Cleveland, OH 44115.
PUB TYPE Information Analyses (070) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; *Access to Education; *Black Education; Black Students; College Students; Cultural Influences; Economic Factors; Educational Discrimination; Educationally Disadvantaged; Elementary School Students; Elementary Secondary Education; *Equal Education; Higher Education; *Mathematics Education; Nondiscriminatory Education; Racial Discrimination; *Science Education; Secondary School Students; Social Influences
IDENTIFIERS *African Americans; Afrocentrism

ABSTRACT

This review examines African American students' access to science and mathematics education, their status and achievement in these fields, factors influencing achievement, and strategies to address the current situation. African Americans are highly underrepresented in the scientific and technical fields. This situation should be corrected because the nation will need increasing numbers of citizens in these areas, because it is in the interest of the African American community to have their community represented in these important fields, and because greater representation will address social inequity. Statistics on black students' performance in mathematics indicate that they are the poorest performers of any group. This situation may be influenced by historical, psychosocial, institutional, behavioral, cognitive, and cultural factors. Proposed solutions to the problems of minority underrepresentation in science and engineering include structural reform of the public school system; Afrocentric education; intervention programs; increased roles for black colleges and universities; black self-help and community programs; and collaborative models involving the government, business, education, and community. Seven graphs are included. (Contains 36 references.) (JB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 361 456

Providing African-American Students Access to Science and Mathematics

by

Robert C. Johnson

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

W. L. Reed
Urban Child Research Center

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Robert C. Johnson, Ph. D.
College of Social Sciences
St. Cloud State University
Copyright © 1992

ED 029468

BEST COPY AVAILABLE

Through this series of publications the Urban Child Research Center is making available copies of selected reports of research conducted under the auspices of the Center. The analyses and conclusions contained in these papers are those of the authors and do not necessarily represent the opinions or endorsements of the Urban Child Research Center or Cleveland State University. For information on publications of the Urban Child Research Center, please contact us at the address below:

Wornie L. Reed, Director
Urban Child Research Center
Levin College of Urban Affairs
Cleveland State University
Cleveland, Ohio 44115

Providing African-American Students Access to Science and Mathematics

This paper focuses on four issues: 1) The need to provide access to science and technology for African Americans and other underrepresented groups; 2) The status of blacks in science and engineering, including their performance and achievement levels; 3) Factors that account for the current state of affairs of African Americans in science and engineering; and 4) What is being done to address these conditions.

Need for Access

African Americans suffer from a high degree of underrepresentation in scientific and technical fields. According to their population size, African Americans are underrepresented disproportionately by a factor of 4.62 in the general U. S. science and engineering work force, and by a factor of 7.5 among doctoral-level scientists and engineers (see Table 1). In other words, African Americans represent only 22% of their expected numbers in scientific and technical fields, and only 13% of their expected numbers among doctoral-level scientists.

The current status of black Americans in science and engineering can be characterized by two conditions, lack of parity (statistical representation) and lack of equity. Data from several sources point to the lack of representation of blacks in the science and engineering areas. Blacks are 12% of the U. S. population, 10% of the U. S. work force, 6.7% of professional workers in the United States, but represent only 2.6% of the scientific and engineering work force and only 1.6% of the doctoral level of scientific and engineering work force. In short, the higher the level of science and engineering activity, the greater the degree of black underrepresentation.

Underrepresentation of major social groups, i.e. people of color, women, and the physically handicapped, is a major national problem. There are several reasons for providing access to socially marginal and underrepresented groups: national need; the needs of these groups; and social equity.

Table 1
Index of Underrepresentation in Science and Engineering, by Race

Group	A. Percent of U.S. Population (1990)	B. Percent of U.S. S&E Workforce (1988)	C. Percent of Employed S&E Doctorates (1989)	Selectivity Indexes	
				A/B	A/C
American Indians	0.8	0.8	0.17	1.0	4.7
Asians	3.0	5.0	9.0	0.6	0.3
African Americans	12.0	2.6	1.6	4.6	7.5
Hispanics	9.0	1.8	1.8	5.0	5.0
White Females	38.4	16.0	15.0	2.4	2.6
White Males	36.8	74.0	73.0	0.5	0.5

Scientific and Technical Needs of the United States.

Many observers from government, industry, the military, and the scientific communities have noted the severe consequences for American society if adequate numbers of citizens are not prepared for scientific and engineering careers. The quality of life of all Americans, and indeed of many people in the world would be adversely affected by the inability of this society and others to produce goods and services beneficial to human beings. Concern about the United States' ability to compete in the international market contributes greatly to the awareness of underrepresentation in the United States.

A 1987 survey of state governors, senior officers of U.S. companies, and presidents and deans of U.S. colleges and universities, found that 90% of the business respondents, 97% of the university respondents, and 86% of state government respondents, rated "developing and maintaining an adequate supply of scientific and engineering personnel as a critical issue in the competitiveness of the United States economy" (National Governors' Association and The Conference Board, 1987, p. 10). These groups also identified other top human resource issues: the preparation of elementary and secondary students in science and mathematics, the supply and quality of science teachers, and the preparation of undergraduate students in science and engineering curriculum.

The National Science Foundation estimates that by the year 2000, as many as 430,000 jobs in the natural sciences and engineering may go unfulfilled (KUOM Radio, 1991). This critical shortage of trained personnel puts the United States at risk in terms of the economy, national security, international competitiveness, health care, scientific research, and the production of consumer goods. The United States clearly has a need to provide greater access to science and engineering education for its citizens.

People of color, women, and disabled citizens have for some time been recognized as potential sources of scientific and technical personnel. These groups are becoming a larger part of the American work force, and people of color and immigrants are representing a larger segment of the American population. On the other hand, white males are expected to be a smaller proportion of the American work force, and are also showing less interest in science and technology as careers.

Many observers note that the ability of the United States to compete effectively in the global market depends greatly on the quality and size of our scientific, technical and engineering personnel. Eric Bloch, former director of the National Science Foundation, has stated the issue succinctly: "an issue of paramount concern is the supply and quality of human resources available for this country's scientific and technological activities. Science and engineering personnel are vital in meeting national challenges in areas such as scientific research, education, technological competitiveness, and national defense" (National Science Foundation, 1990, p. iii).

Group Self-Interest.

Providing access to members of socially marginal groups is important to these groups as well. People of color, females and disabled people tend to be underrepresented in areas that have great impact on their lives and on the lives of people in this society. Such is the case with science and technology. Examples from African-American history and culture make this point clear (Johnson, 1984). Technological developments that lead to the era known as the Industrial Revolution created a greater demand for goods produced by slaves, thus expanding slavery and the slave trade. Agricultural mechanization coupled with urban industrial development caused many blacks to leave the rural south to head for urban areas in the south and in the north, creating the urban black presence. The invention of the automobile, new building materials and new building techniques, and the creation of interstate systems made the suburbanization of America and the isolation of blacks in inner cities possible.

Today, information and telecommunication technologies are being used by neo-Nazi and hate groups to disseminate their messages of racial hatred. Some Klan groups are using local cable access policies to air programs in their communities (for example, the Race and Reason cable television show in Kansas City). An article in the March, 1992 issue of *The Readers Digest* discusses David Duke's use of computerized direct mail techniques to raise funds and to send his message to thousands of individuals around the country. *PC Computing* magazine has identified electronic bulletin boards and networks used by hate groups to share information, messages, and communications (Stills, 1989). News reports in the Twin Cities tell of white supremacists leaving messages on answering machines inviting

people to call a number and to listen to prerecorded hate messages (WCCO, 1992). Technology is still being used to oppress members of socially marginal groups.

Recent reports indicate that blacks have environmental concerns and awareness (Dolin, 1989; Wilson, 1990) and some blacks believe "environmental racism" is a serious problem that affects communities of color. Environmental racism occurs when communities of color are disproportionately affected and targeted by business and governmental actions which have negative environmental impacts and harmful consequences for the individuals living in the affected areas. Examples include exposing residents to toxic waste, placing unsafe facilities in their communities, failing to clean up dangerous environmental conditions, and not providing residents with information on and treatment of the health consequences of exposure to these dangerous environmental conditions (Bolin & Klenow, 1988; Johnson & Oliver, 1989). A scientifically literate and aware community can protect itself much better against such abuses than a community without scientific and technological knowledge.

Social Equity.

Inequity is a factor in the current status of blacks in science and engineering because of the magnitude of issues facing the black community. AIDS, environmental pollution, health care, transportation, energy, employment, urban development, and housing are examples of areas to address requiring knowledge of science and engineering. Yet, the black community which is disproportionately affected by these types of concerns is the least prepared in terms of trained personnel to address them.

Another type of equity issue is social opportunity. High-paying jobs and rewarding careers are available in the science and technical areas. Yet people of color and females are underrepresented in these areas and thus are missing opportunities. The lack of preparation in science and mathematics will exacerbate this inequity. In addition to the lack of career opportunities, disparity in jobs in the science and technical area will also mean that African Americans and other members of socially marginal groups will not be in decision making positions that affect the lives and well being of members of their community and members of the society at large. Thus, access to careers in these areas is important from both an individual and collective perspective.

Black Performance and Achievement Levels

How likely is it that the United States will make up the scientific and technical shortage and fulfill President Bush's goal to be number one in the world in math and science education? The prospect of meeting this objective is not very promising under current educational, economic, and social conditions. Not only are we facing a shortage of scientific and engineering personnel at a time of increased international competition, we are confronted with poor national performance in mathematics and science. Tables 2 and 3, based on data from the international assessment of student performance in math and science, show the U.S. rankings in these areas among the countries whose students were tested. It is clear that a great deal more work needs to be done at the national level to prepare our students to compete favorably with students from around the world.

Within the context of reviewing American students' performance, it is instructive to examine the performance of African-American students to ascertain the extent to which they are ready to assume a greater presence in the science and engineering professions. Table 4 presents findings from the 1990 national assessment of mathematics proficiency of students in grades 4, 8, and 12 (National Assessment Governing Board, 1991).

There are three levels of mathematics achievement defined for each grade level: advanced—superior performance; proficient—solid academic performance; basic——partial mastery of knowledge and skills. Results for African-American students are shocking and shameful. Almost no black students score at the advanced level and the vast majority, between 95 to 98%, score at the basic level or below. Essentially, the findings from this assessment indicate that most black students have less than partial mastery of grade-level math skills and knowledge.

What these data suggest is that black students as a group, on the average, are the poorest performers among a nation of poor performers. Other studies and data support this position. The data in Table 5 show that among the larger racial/ethnic groups—blacks, whites, and Hispanics—blacks persistently achieve the lowest average scores on national assessment measures.

Table 2

Comparative Ranking of 13-Year-Olds on Science Assessment

Country	Average Percent Correct
Korea	78
Taiwan	76
Switzerland	74
Hungary	73
Soviet Union	71
Slovenia	70
Italy (Emilia-Romagna)	70
Israel	70
Canada	69
France	69
England	69
Scotland	68
Spain	68
UNITED STATES	67
China	67
Ireland	63
Portugal	63
Jordan	57
Brazil (Sao Paulo)	53
Brazil (Fortaleza)	46

Source: International Assessment of Educational Progress, 1992a

Table 3

Comparative Ranking of 13-Year-Olds on Mathematics Assessment

Country	Average Percent Correct
China	80
Korea	73
Taiwan	73
Switzerland	71
Soviet Union	70
Hungary	68
France	64
Italy (Emilia-Romagna)	64
Israel	63
Canada	62
Scotland	61
Ireland	61
England	61
Slovenia	57
Spain	55
UNITED STATES	55
Portugal	48
Jordan	40
Brazil (Sao Paulo)	37
Brazil (Fortaleza)	32
Mozambique	28

Source: International Assessment of Educational Progress, 1992b

Table 4

Percentage of Students At or Above Achievement Levels By Grade and Race/Ethnicity
1990 NAEP Mathematics Assessment

GRADE Race/Ethnicity	ACHIEVEMENT LEVELS Basic	Proficient	Advanced
GRADE 4			
White	73.6	19.0	.8
Black	30.3	2.1	0
Hispanic	41.6	5.2	0.1
Asian/Pacific Islander	77.8	28.5	1.7
American Indian	55.6	5.5	0.2
Total	63.3	14.9	0.6
GRADE 8			
White	71.7	22.3	1.2
Black	29.6	4.2	0
Hispanic	40.2	6.1	0
Asian/Pacific Islander	82.2	38.9	6.4
American Indian	41.6	5.1	0
Total	62.1	18.1	1.0
GRADE 12			
White	71.8	19.2	3.0
Black	33.6	2.1	0.1
Hispanic	42.8	6.1	0.5
Asian/Pacific Islander	82.8	34.0	8.8
American Indian	***	***	***
Total	64.4	16.2	2.6

*** Sample size insufficient to permit reliable estimate. There were fewer than 62 students.

Source: National Assessment Governing Board, 1991, Table 2.2, p. 37.

Table 5

Average NAEP Science and Math Scores, by Ethnicity, 1977 - 1990

GROUP	MEAN SCIENCE SCORES				MEAN MATH SCORES			
9-YR-OLD	1977	1982	1986	1990	1978	1982	1986	1990
Black	174.8	187.0	196.2	196.4	192.4	194.9	201.6	208.4
White	229.6	229.0	231.9	237.5	224.1	224.0	226.9	235.2
Hispanic	191.9	189.0	199.4	206.2	202.9	204.0	205.4	213.8
13-YR-OLD								
Black	208.1	217.1	221.6	225.7	229.6	240.4	249.2	249.1
White	256.1	257.3	259.2	264.1	271.6	274.4	273.6	276.3
Hispanic	213.4	225.5	226.1	231.6	238.0	252.4	254.3	254.6
17-YR-OLD								
Black	240.2	234.7	252.8	253.0	268.4	271.8	278.6	288.5
White	297.7	293.1	297.5	300.9	305.9	303.7	307.5	309.5
Hispanic	262.3	248.7	259.3	261.5	276.3	276.7	283.1	283.5

Source: National Assessment of Educational Progress data files, U.S. Department of Education, author.

Factors Related To Underrepresentation and Underachievement

There are a number of causes and factors related to the underrepresentation and underachievement of people of color and females in the sciences. These factors may be identified as: historical, psychosocial, institutional, behavioral, cognitive, and cultural. These are outlined below.

Historical factors.

- Past discrimination that prevented African Americans from pursuing education and careers in the sciences
- Systematic campaign to inculcate a sense of inferiority and shame in African Americans, leading to a lack of confidence

Psychosocial factors.

- Attitudes toward quantitative subjects; aspirations; role models; attribution (to what a person attributes success in math and science); self-esteem; perceived usefulness of quantitative subjects
- Unfamiliarity with these occupations as career options
- Lack of motivation and inspiration on the part of minority students
- Insufficient home, community and peer-group encouragement
- Family income and parental income

Institutional factors

- Lack of adequate counseling
- Inadequate academic preparation at the elementary and junior high school level
- High drop-out rates at the college and professional school levels
- Need for more legislative (and lobbying) action
- Lack of black higher educational institutions' involvement in grant, research, and training activities
- Insufficient scholarships and training opportunities for black students
- Lack of an adequate research base on the barriers to minority participation in the sciences
- Quality of high school curriculum
- Precollege enrichment and intervention program
- Racial and gender climate in educational and business institutions

Institutional factors (cont'd)

- Availability of financial assistance
- Recruitment and admission policies
- Perpetuation of racial and gender stereotypes and discrimination
- Support systems and resource people

Behavioral factors

- Differential course-taking in pre-college math and science curriculum
- Differential selection of college majors and courses

Cognitive factors

- Differential performance on standardized tests
- Different learning styles

Cultural factors

- Different world views; different values
- Alternative modes of approaching nature, knowledge and understanding
- Different communication styles
- Cultural conflict
- Social and cultural differences of minority groups, and the failure by majority educators to recognize and respect these differences and to take them into account
- Culturally-biased standardized tests

Approaches and Solutions

There are several proposed solutions to the problem of minority and female underrepresentation in science and engineering. These include: structural reform of the public school system; Afrocentric education; intervention programs; increased roles for black colleges and universities; black self-help and community programs; and collaborative models involving the government, business, education, and community. These approaches are not mutually exclusive, even though for discussion purposes they will be treated separately.

Structural Reform

The most frequent and strongest calls for reform are directed at the public schools. These calls range from a total restructuring to changes in science and math education curriculum, teaching materials and delivery methods, or to reforms in teacher training in science and math education.

The Quality Education for Minorities Project (1990) recently issued a call for fundamental restructuring of the nation's schools and educational systems:

> No subject is more important to providing quality education for minorities than the restructuring of the schools. The consensus building around the country...is that schools must be fundamentally restructured so that student achievement becomes the primary criterion by which teachers and administrators are judged and rewarded. Efforts at restructuring must value minority students; assume responsibility for their learning; be sensitive to their backgrounds, language, and cultural values; and be adequately funded. Any national goals for education ...must include a vision to improve the education of our students (p. 3).

Other groups have been less far-reaching in their calls for reform. Yet they champion extensive changes in the way mathematics and science is taught to students (American Association for the Advancement of Science, 1989a; 1989b; Cheeks, 1984; Mathematical Sciences Education Board and National Research Council, 1990; National Council of Teachers of Mathematics, 1989; National Research Council, 1989). Reform proposals along these lines emphasis more on hands-on activities, laboratory exercises, active student involvement, problem-solving skills and conceptual understanding of these subjects, and less emphasis on lecturing, on memorization of large amounts of "facts" and rules, and on rote learning. Proponents of change also encourage more attention to the social, cultural and historical context and development of these subjects.

Another aspect of structural reform centers on teacher roles, training and teacher quality. Teacher education programs must do a better job of preparing educators who are competent in and comfortable with mathematics and science. More science and math educators are needed, and current school teachers need additional training in science and math education. The Mathematics Science Education Board and National Research Council report (1990) suggests that teachers should be "intellectual coaches", playing the roles of role model, consultant, moderator, interlocutor, and questioner. Teacher attitudes toward children of color and their cultures also are an important area for change (Jones, 1990).

New instructional materials are necessary to carry out the reforms in science and math education. In addition to new textbooks, workbooks and other text materials, new audiovisual materials need to be developed to accommodate new teaching strategies, new curricular goals, and different learning styles. Reformers want more use of newer technologies such as computers, calculators, and interactive materials. Alternative and different assessment methods and measures are needed to overcome the limitations and biases of traditional testing and assessment. The EQUALS (1989) project in California maintains that assessment should promote learning. Their ideas for assessment alternatives in mathematics include: student portfolios, writing in mathematics, investigations in mathematics, open-ended questions, observations, interviews, and asking questions.

Elimination of tracking, more equitable distribution of resources, and more funding for schools are other factors noted as means to address the underrepresentation and underachievement of students of color in science and mathematics (Oakes, 1990).

Afrocentric Approaches

Afrocentric education in public schools has become a hot and controversial news item in recent years. However, the Afrocentric approach to education has its roots outside of the public schools, and has a long tradition dating back to the "African Free Schools" established by free blacks in the 18th and 19th centuries (Bond, 1966). "Freedom Schools" from the Civil Rights era represented this concept in more recent times. And some independent, privately-owned black institutions embody this concept today. Afrocentric education is viewed as a means of achieving educational excellence for African-American students with its emphasis on an African-based perspective.

For a number of years, African-American educators proposing an Afrocentric approach to education have recognized the importance of science and technology to the well-being of African Americans and Africans. In a 1974 study of the relationship of telecommunication technology and the socialization of black Americans, I concluded: "Blacks that foresee the coming challenge and potential of technology in education (and its current social impacts) and who advocate its use are usually of a Pan-Africanist/Black Nationalist orientation and/or are engaged in higher education (usually in special services or research) or in policy-making endeavors (for government, private and public organizations)" (Johnson, 1974).

This recognition of the importance of science and technology continues to be found among Afrocentric proponents, although it is much more widespread today. In an attempt to meet the educational needs of African-American children, a number of private black schools have been established stressing academic excellence and achievement, especially in math and science. These institutions hold regional and national science fairs to encourage and showcase the talents of African-American youths. Ratteray reports that 62 % of the students in a recent study of independent neighborhood schools were above the national norm in mathematics (Ratteray, 1991).

While these institutions may not yet have a totally African-centered curriculum (Ratteray, 1990), they possess characteristics which foster achievement. Dedicated teachers, strong parental support, role models, a strong focus on discipline, incorporation of African-American and African content in the curriculum, emphasis on black pride and heritage, and focus on community development and responsibility are some of the elements which account for their success. They also offer relatively inexpensive education compared to public and other types of private schools.

The Afrocentric approach and the independent black school movement have limitations. Only a fraction of black students are enrolled in such programs. The Institute for Independent Education (April, 1990) estimates for 1988-89 that 52,744 African-American students were enrolled in schools associated with the independent black school movement and another 278,000 black students were enrolled in other types of non-public schools. Overall, 6.7 million black students were in public schools that year. The methods and materials used in such programs are not uniform nor widely available. Little research is available on the accomplishments and effectiveness of these institutions. Many public school teachers are not

willing to work for the low wages, nor do they possess the commitment to black children that teachers in these institutions have. In spite of these limitations these schools are worthy of further study and consideration for the lessons they can impart about black academic achievement.

Intervention Programs

Intervention programs aim to involve students of color and females in interesting and meaningful science and math activitites early in their academic careers. Some programs start at the lower elementary grades, some are for middle-school students, and others are geared for high-school and college students. This approach has proliferated over the past two decades, and programs are now sponsored by colleges and universities, state and federal agencies, private industry, foundations, professional societies, community groups, and public schools.

The format and content of these programs vary. George, Chu-Clewell, and Watkins (1987) identified these components in precollege mathematics and science programs: career days; field trips to science museums and zoos; test-taking skills workshop; contests and competitions; academic programs (Saturday math and science academies; after-school clubs; summer science and math programs; computer camps; university accelerated programs); and internships (in universities and industry).

A study of intervention programs found that these programs not only hold promise for people of color, females and disabed students, but "for the general improvement of education in the sciences and mathematics for all persons" (American Association for the Advancement of Science, 1984, p.6). Exemplary intervention programs have characteristics which reflect those called for in the reform literature. The American Association for the Advancement of Science (AAAS) study cited the following characteristics:

1. Strong academic component in mathematics, science, and communications focused on enrichment rather than remediation;
2. Academic subjects taught by teachers who are highly competent in the subject matter and believe that students can learn the material;
3. Heavy emphasis on the applications of science and mathematics, and on careers in these fields;

4. Integrative approach to teaching that incorporates all subject areas, hands-on opportunities, and computers;
5. Multiyear involvement with students;
6. Strong director and commited and stable (low turnover) staff who share program goals;
7. Stable, long-term funding base with multiple funding sources (so that staff do not spend most of their time hunting for money);
8. Recruitment of participants from all relevant target populations in an area;
9. University, industry, school, etc. cooperative program;
10. Opportunities for in-school and out-of-school learning experiences;
11. Parental involvement and development of base of community support:
12. Specific attention to removing educational inequities related to gender and race;
13. Involvement of professionals and staff who look like the target population;
14. Development of peer support systems (involvement of a "critical mass" of any particular kind of student);
15. Evaluation, long-term follow-up, and careful data collection; and
16. "Mainstreaming"--integration of program elements supportive of women and minorities into the institutional programs.

While there are scores of intervention programs at all levels, and while there is indirect evidence that they impact the problem of underrepresentation by increasing the number of black students in the scientific pipeline (AAAS, 1984; Chu-Clewell, Thorpe, & Anderson, 1987; Johnson, 1989), they alone are not a panacea to the problem of access and equity for African Americans. Many of these programs are still "outside" of the school system, even though they work with schools and teachers. Those programs are generally expensive, therefore limiting the number of students who can be served. Some are elitist, serving only high-achieving students, and ignoring many students who could benefit from them.

In spite of these and other limitations, intervention efforts are important because: 1) they offer a remedy, albeit short-term and limited, to a critical problem; 2) they demonstrate what could be done if there is willingness and resources; 3) they represent collaborative efforts involving schools, universities, business, and government; and 4) they are developing and modeling curricula and teaching approaches that work with African Americans and other underrepresented groups.

Black Colleges and Universities

Black colleges and universities are in the forefront of producing African-American scientists and technologists. Five black institutions were among the top ten schools producing black engineering graduates in 1987-88. Indeed, four of the top five schools were black institutions (McDonald, Clarke & Dobson, 1990). The National Governors' Association (NGA) notes, "One-third of all bachelor's degrees and one-half of the mathematics bachelor's degrees awarded to black students are awarded by such institutions. Only seven historically black colleges and universities offer at least one accredited engineering degree program, though in 1989 these schools granted 19% of the engineering bachelor's degrees awarded to black students (NGA, 1987, p. 14)." The NGA report cites supportive environments, high faculty expectations, the presence of role models, and a predominantly black environment are factors in black institutions' success.

These findings are not surprising given the historic role black colleges have played in producing black talent and the less than admirable record of white colleges in recruiting and graduating African Americans. In the overall equation for improving access and equity for African Americans, the black college is a major factor. In addition to their success with college students they host precollege intervention programs, and some have excellent laboratory schools. The unfortunate side to their story is that only a minority of African-American students attend such institution and they are unable to accommodate the increasing demand for admission to their institutions.

Black Self-Help Initiatives

Black organizations and community groups are deploying their human, financial and organizational resources to combat the lack of adequate representation of African Americans in science and technology. Wilson (1989) describes one such effort which is a collaboration

between a black Baptist church and a chapter of a black engineering society. Their goal is to help underachieving junior-high school students to acquire the skills necessary for a successful high school and college career. Miller (1991) discusses the Young Black Scholars program which was started by black professionals and educators in Los Angeles to improve the academic skills of eigth grade black students and their chances to attend college.

Black professional organizations such as the National Technical Association and the Society of Black Engineers have programs to encourage, support, and increase black participation in technical fields. Other black scientists and engineers are active in their professional organizations' efforts to increase minority and female representation, often spearheading or serving as a catalyst for these efforts. Some are responsible for their corporations' involvement in school and community programs. Other black professionals and scientists initiate, coordinate, and/or participate in intervention programs at predominately white institutions.

Black self-help initiatives are no substitute for local, state, and federal governmental efforts, with whom the primary responsibility rests for meeting national needs in scientific personnel. Black initiatives are an important component in addressing this problem because of their grassroots connections, their cultural understanding and sensitivity, and their commitment.

Collaborative Alliances

This arrangement is defined as follows: "A local alliance for improving education in science and technology is a partnership of business, industry, labor, professional associations, educators, and other concerned groups" (Triangle Coalition for Science and Technology Education, 1986)

Because of business leaders' concerns about the quality of the labor force and its impact on the United States' competitiveness in the international market, collaborative arrangements could lead to improvements in the educational offerings of African-American students. Businesses are willing to provide resources, personnel, equipment, facilities, and public relations expertise to schools and intervention programs. They also afford educators and community organizations access to other financial and human resources. These partners may be able to pressure recalcitrant public officials to support educational programs serving inner-city or African-American students.

Colleges and universities bring many resources to such a collaboration: scientists and engineers, specialists in minority affairs, research and evaluation expertise, modern facilities (laboratories, dormitories, etc.). Students who attend residential programs get the experience and benefits of living and working in a college environment, and an opportunity to interact with college personnel and students. This experience also exposes them to college majors in the sciences and engineering, and the requirements for these majors prior to going to college.

Government agencies are now responding to the problem of underrepresentation. The National Science Foundation, the Departments of Energy and Education, National Aeronautics and Space Administration, and other agencies are providing funding for academic programs for students, research, curriculum development, teacher training,
alternative assessment methods, and dissemination. This support, while long overdue and still not at a level sufficient to address the magnitude of the problem, gives schools, community groups, universities, and local alliances means to organize and implement programs.

African-American community and professional groups participating in such a partnership receive additional financial, human, and material resources. They provide other members of the alliance with access to students whose potential may remain untapped, people who can work with parents and others in the community, and technical and cultural expertise. Parents and students are the ultimate beneficiaries of collaborative efforts if they lead to lasting educational change and social opportunities.

While these arrangements can be beneficial to all parties concerned, they may be problematic, especially to African-American communities. If these "partnerships" attempt to maintain existing social power arrangements, with business, government and education representatives assuming paternalistic postures vis-a-vis communities of color, then the arrangement is business as usual. Sometimes these alliances are replications of elitist social and political orders in the local, state, and national arena, where power brokers attempt to dictate and define what is best for African Americans. Obviously, an arrangement of this nature is not in the best interest of the African-American community, nor ultimately in the best interest of the nation.

Conclusions

What has been the overall, cumulative effect of these efforts to increase African-American achievement and participation in science and mathematics? Figures 1-6 shows that black scores on science and mathematics achievement tests have inched upward over the past two decades. However, black proficiency in these subjects is below par so the progress is not sufficient. Indeed, the majority of the nation's youth, regardless of race, is performing below acceptable and international levels.

On the other hand, the data in Figure 7 show that the number of blacks earning degrees in the natural sciences, mathematics, and engineering has been increasing steadily although overall black college enrollment has been declining. While a causal relationship is difficult to make in the absence of experimental controls, the increase in the production of black scientific and technical personnel does correspond to the array of efforts to increase their numbers. It seems that these efforts are producing results.

The nation is facing a dire problem of producing an adequate pool of scientific and technical personnel. This problem plagues most groups in the society, but African Americans more severely than most others. Progress toward redressing this inequity is slow, but a number of promising efforts are underway with some positive results. Greater public recognition and additional efforts similar to those described above will make a difference.

Unfortunately, the problem of black underrepresentation in the sciences is not only an educational problem. It is rooted in a myriad of social and historic issues: societal portrayals of African Americans; past and present discrimination; poor social and economic opportunities; poor health conditions to name a few. To accomplish profound changes in the educational performance of African-American children, profound and lasting social changes are in order.

African-American parents and community organizations can use the list of characteristics of exemplary programs, the goals of reform efforts, the characteristics of black colleges, and local alliances to force local school districts to become more responsive in meeting the needs of their children. They also have to attend to the other types of problems facing the black community in order to prepare their children for the challenges of the 21st century. Thus, it is extremely important that African-American parents and groups take a very proactive approach to this issue. Action and involvement are keywords in this scenario.

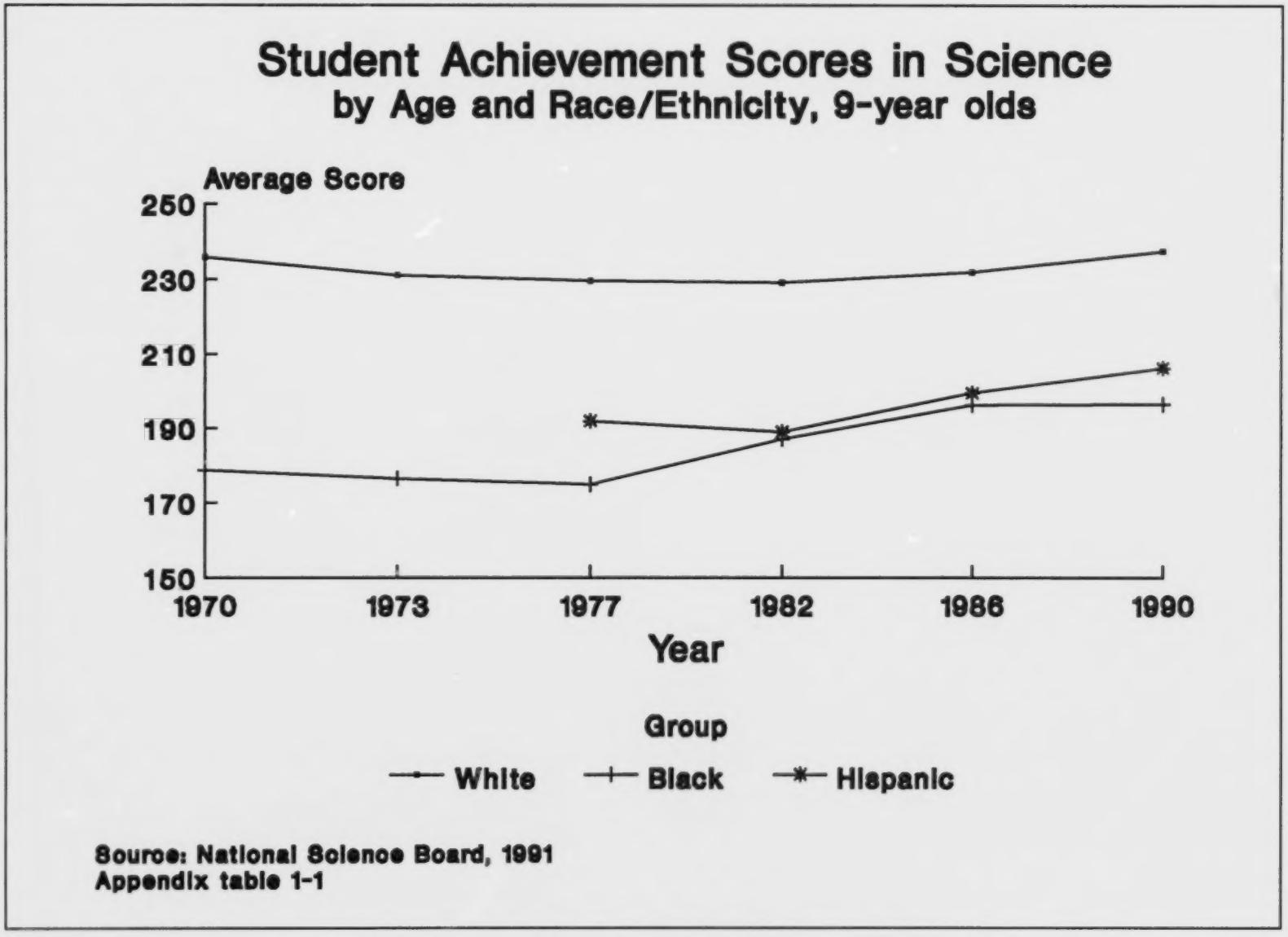

Student Achievement Scores in Science
by Age and Race/Ethnicity, 9-year olds
Average Score
250
230
210
190
170
150
1970
1973
1977
1982
1986
1990
Year
Group
White
Black
Hispanic
Source: National Science Board, 1991
Appendix table 1-1

Figure 1
22

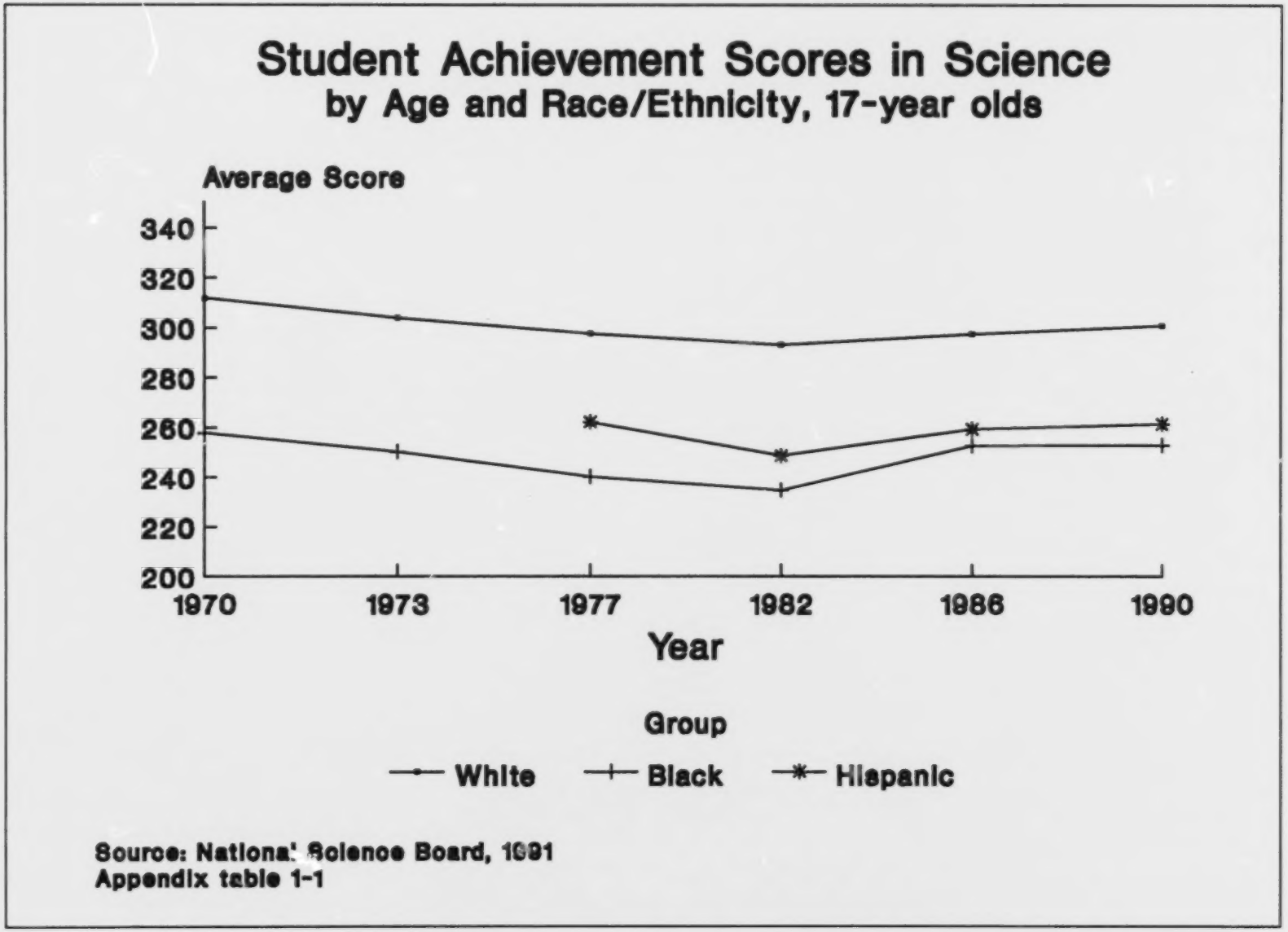
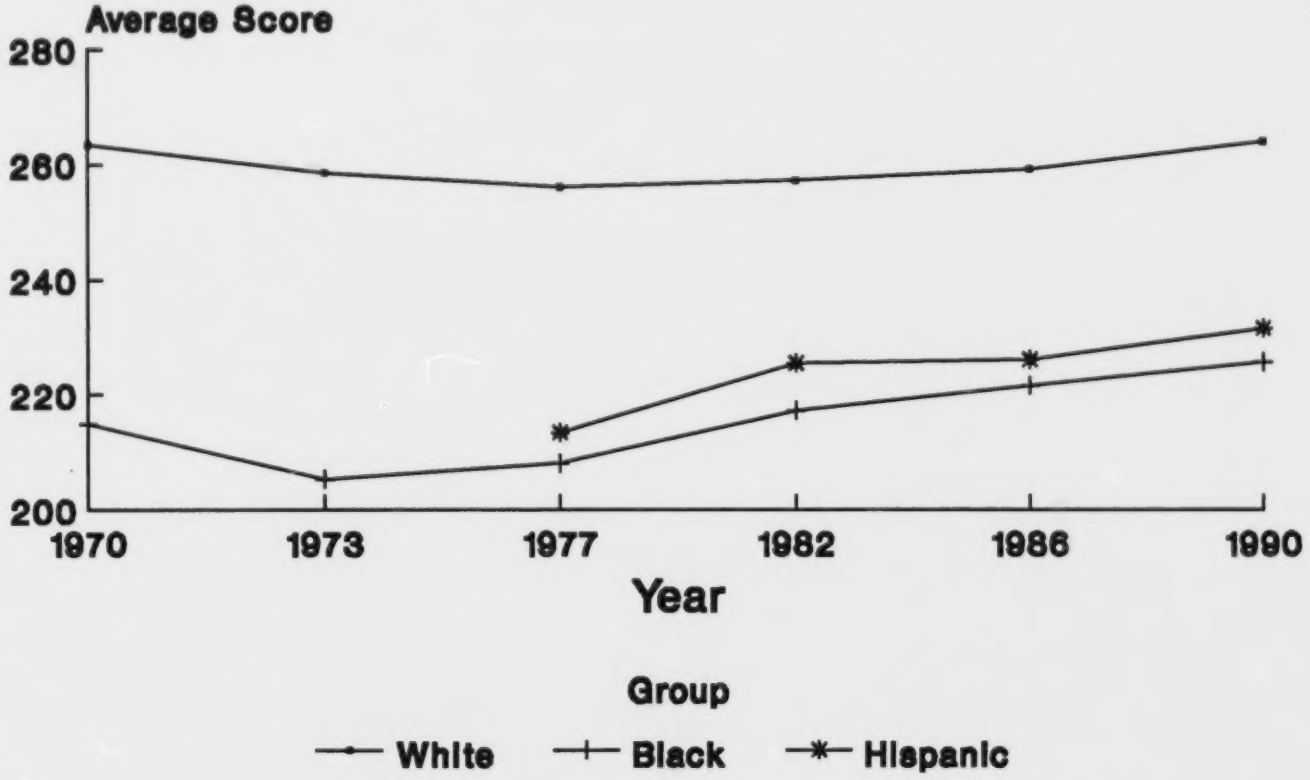

Student Achievement Scores in Science
by Age and Race/Ethnicity, 17-year olds
Average Score
340
320
300
280
260
240
220
200
1970
1973
1977
1982
1986
1990
Year
Group
White
Black
Hispanic
Source: National Science Board, 1991
Appendix table 1-1

Figure 2
23

Student Achievement Scores in Science, by Race/Ethnicity, 13-year olds, 1970-90



Source: National Science Board, 1991
Appendix table 1-1

Figure 3
24

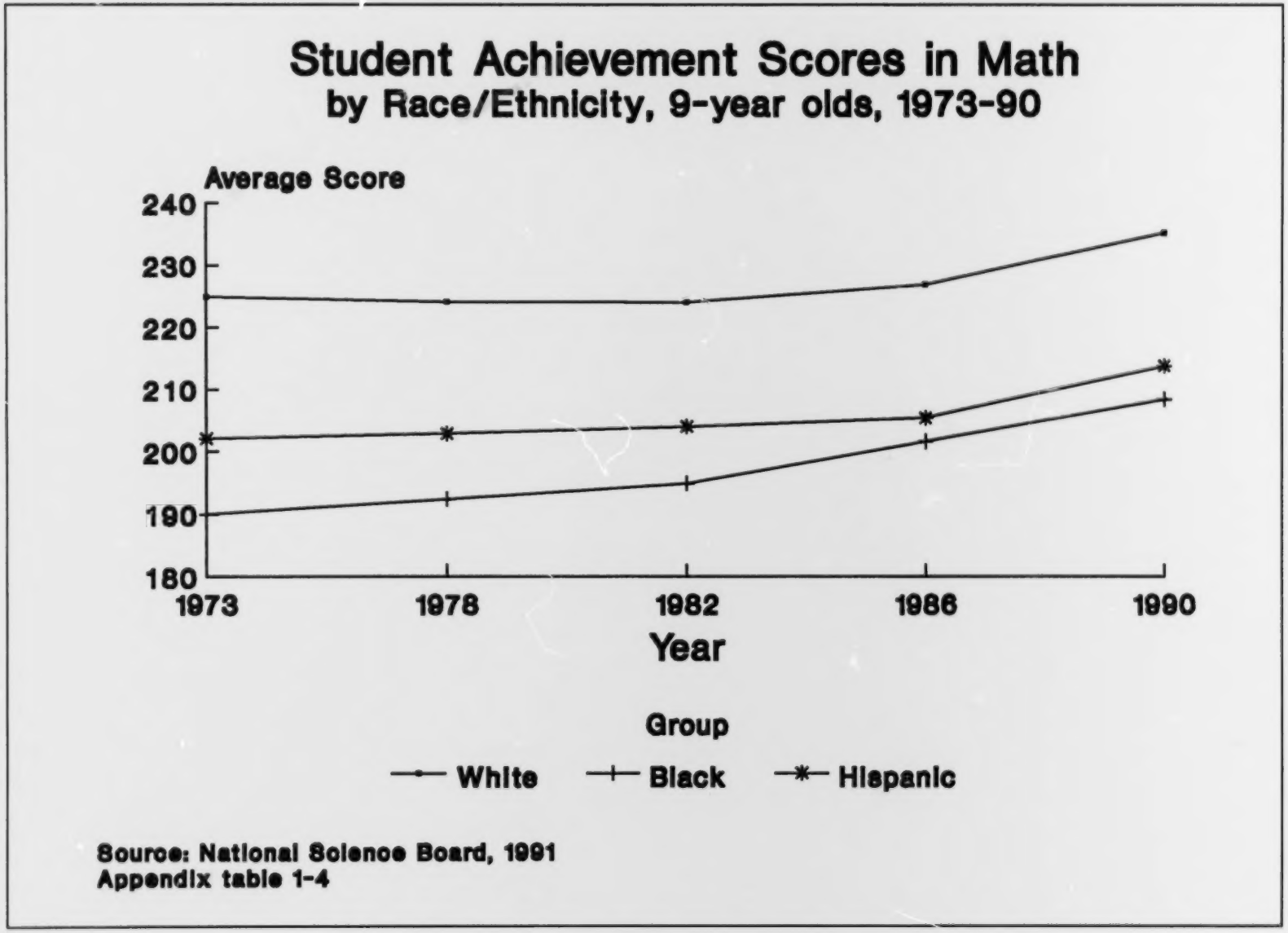
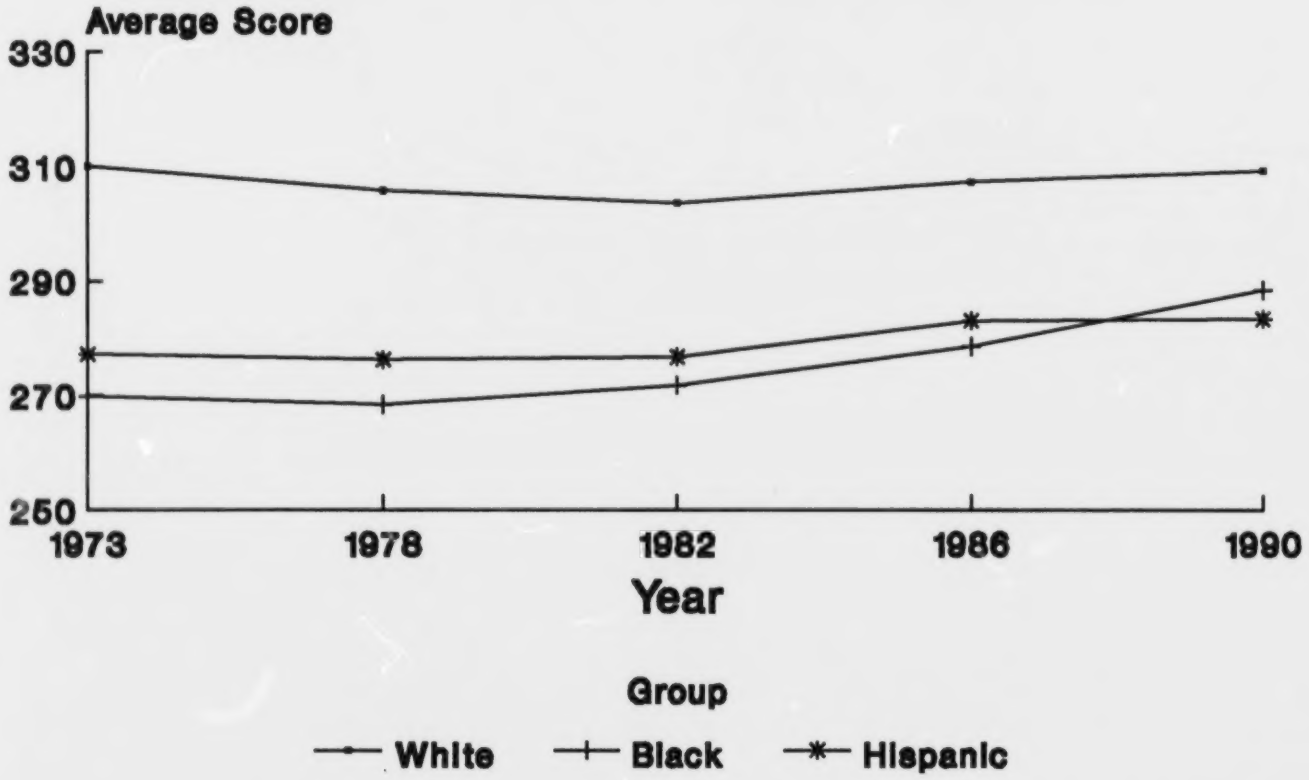

Student Achievement Scores in Math
by Race/Ethnicity, 9-year olds, 1973-90
Average Score
240
230
220
210
200
190
180
1973
1978
1982
1986
1990
Year
Group
White
Black
Hispanic
Source: National Science Board, 1991
Appendix table 1-4

Figure 4
25

Student Achievement Scores in Math
by Race/Ethnicity, 17-year olds, 1973-90



Source: National Science Board, 1991
Appendix table 1-4

Figure 5
26

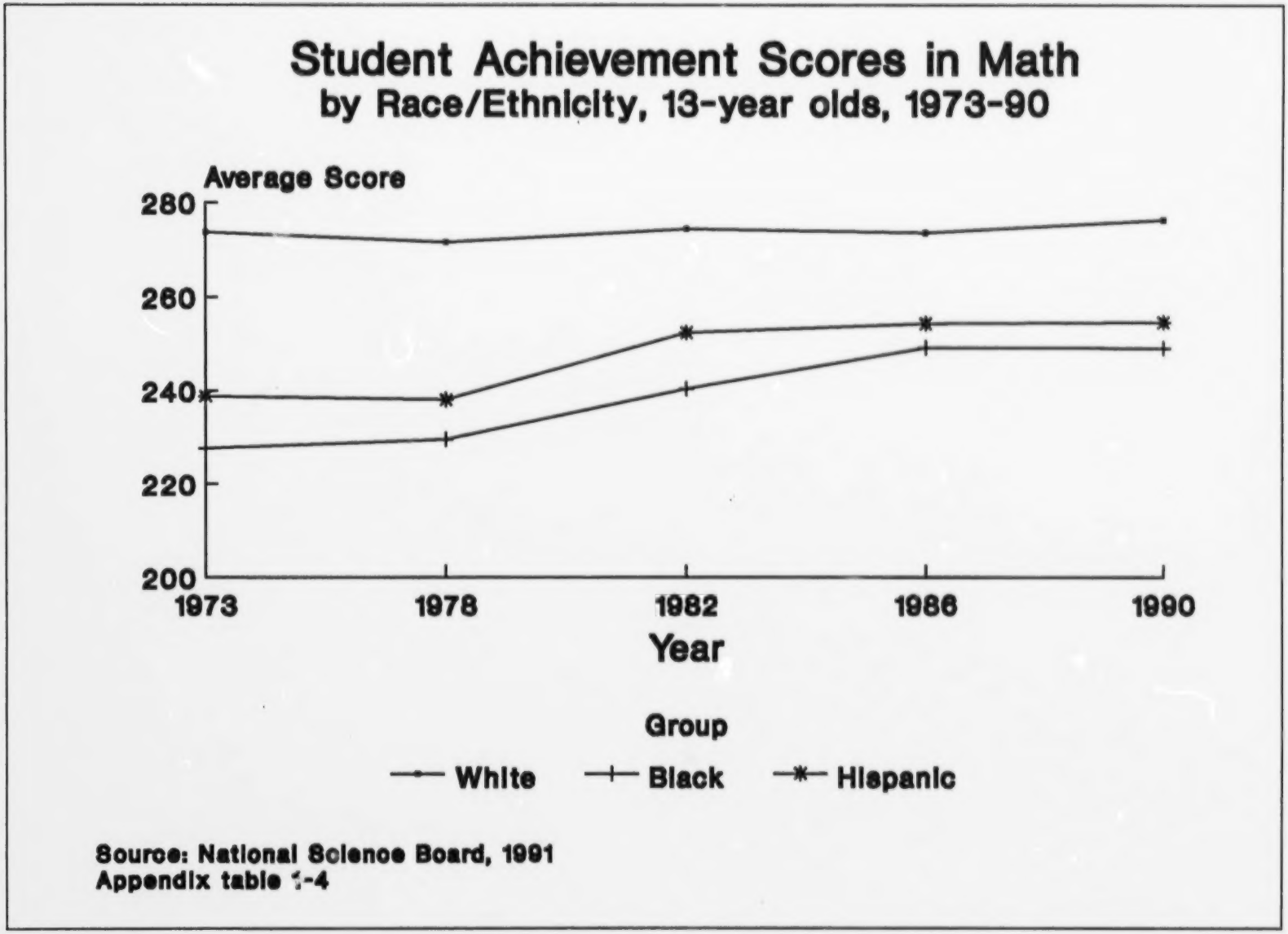

Student Achievement Scores in Math
by Race/Ethnicity, 13-year olds, 1973-90
Average Score
280
260
240
220
200
1973
1978
1982
1986
1990
Year
Group
White
Black
Hispanic
Source: National Science Board, 1991
Appendix table 1-4

Figure 6
27

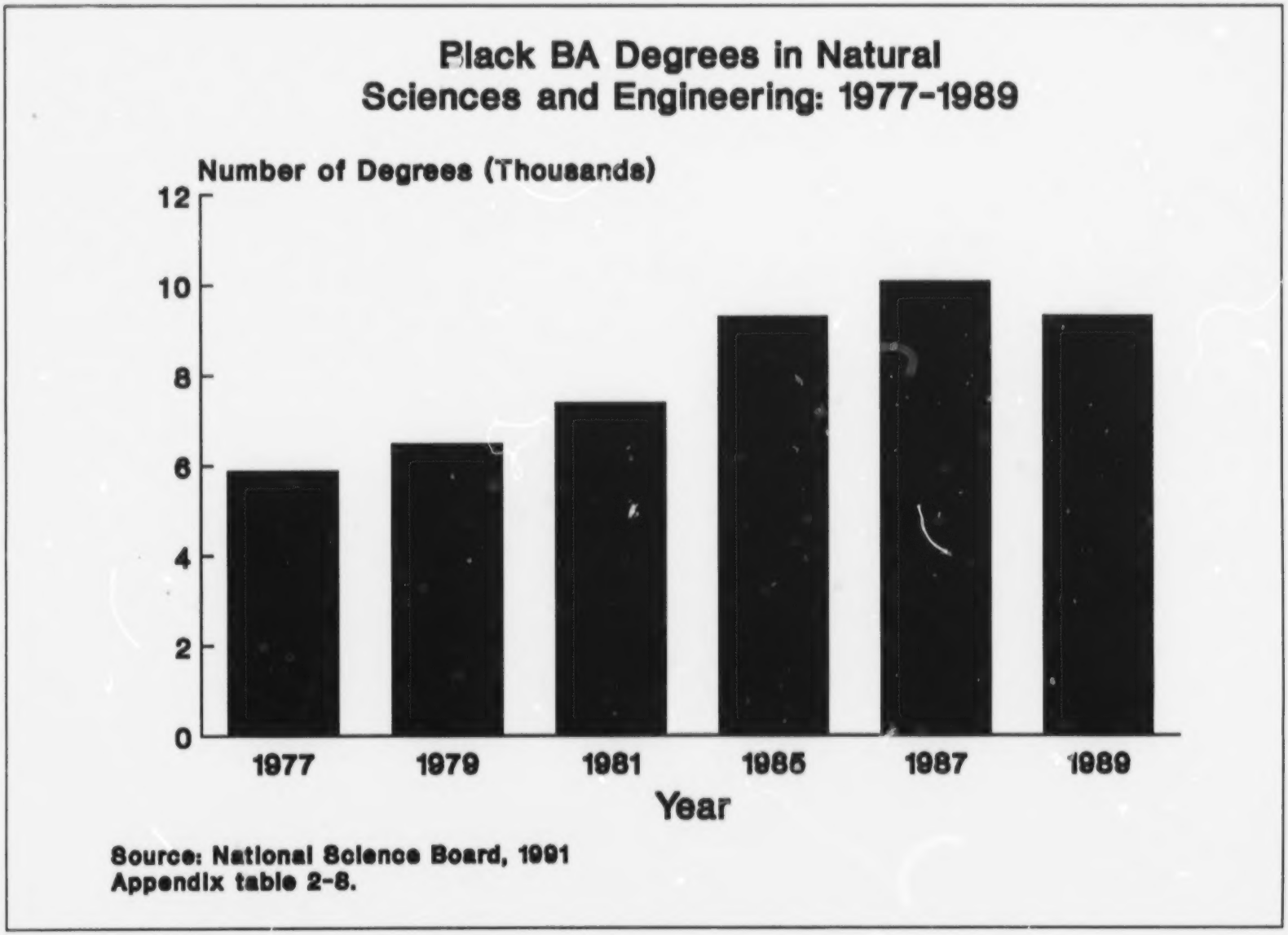


Figure 7
28

BEST COPY AVAILABLE

References

American Association for the Advancement of Science. (1989a). *Mathematics; A Project 2061 Panel Report.* Washington, DC: American Association for the Advancement of Science.

American Association for the Advancement of Science. (1989b). *Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology.* Washington, DC: American Association for the Advancement of Science.

American Association for the Advancement of Science. (1984). *Equity and Excellence: Compatible Goals.* Washington, DC: American Association for the Advancement of Science.

Bolin, R. & Klenow, D. J. (1988). Older People in Disaster: A Comparison of Black and White Victims. *International Journal of Aging and Human Development.*

Bond, H. M. (1966). *The Education of the Negro in the American Social Order.* New York: Octagon Books, Inc.

Cheeks, H. N. (Ed.). (1984). *Handbook for Conducting Equity Activities in Mathematics Education.* Reston, Virginia: National Council for Teachers of Mathematics.

Chu-Clewell, B., Thorpe, M. E., & Anderson, B. T. (1987). *Intervention Programs in Math, Science, and Computer Science for Minority and Female Students in Grades Four through Eight.* Princeton, NJ: Educational Testing Service.

Dolin, E. J. (1988). Black Americans' Attitudes Toward Wildlife. *Journal of Environmental Education, 20,* (1).

EQUALS and California Mathematics Council. (1989). *Assessment Alternatives in Mathematics: An Overview of Assessment Techniques that Promote Learning*. Berkeley, California: University of California.

George, Y. S., Chu-Clewell, B. & Watkins, N. (1987, September). "Lessons for HBCUs from Precollege Mathematics and Science Programs." Paper commissioned by the White House Initiative on Historically Black Colleges and Universities for the 1987 Symposium, *Alliances: An Expanded View*.

Institute for Independent Education, Inc. (1990, April). "African American Enrollment in Independent Schools (1988-89)." Research Notes on Education, No. 6, Washington, DC.

International Assessment of Educational Progress. (1992a, February). *Learning Mathematics*. Princeton, New Jersey: Educational Testing Service, February.

International Assessment of Educational Progress. (1992b, February). *Learning Science*. Princeton, New Jersey: Educational Testing Service, February.

Johnson, J. H. & Oliver, M. L. (1989). Blacks and the Toxics Crisis. *Western Journal of Black Studies, 13*, (2).

Johnson, R. C. (1989). "Declining Black Collegiate Enrollment: Implications for Black Participation in Science and Technology," In *Proceedings: Pre-College Education of Minorities in Science and Engineering*, New Jersey Institute of Technology, Newark, New Jersey: New Jersey Institute of Technology Press.

Johnson, R. C. "Science, Technology, and Black Community Development." *The Black Scholar, 15*, (2).

Johnson, R. C. *Telecommunications Technology and the Socialization of Black Americans.* (1974, September). St. Louis, Missouri: Washington University, Program in Technology and Human Affairs and black Studies Program, Report No. THA 74/7.

Jones, J. A. (1990). "Look at Math Teachers, Not "Black English'." Eassy and Policy Studies Series, Institute for Independent Education, Washington, DC.

KUOM Radio, University of Minnesota. (1991). "Science Lives: Women and Minorities in the Sciences, 13-part radio series.

Mathematical Sciences Education Board and National Research Council. (1990). *Reshaping School Mathematics: A Philosophy and Framework for Curriculum.* Washington, DC: National Academy Press.

McDonald, J., Clarke, M. K. & Dobson, E. N. (1990). Increasing the Supply of Women and Minority Engineers: An Agenda for State Action. Washington, DC: National Governors' Association.

Miller, W. F. (1991). "Developing Untapped Talent: A National Call for African-American Technologists." In Janet Dewart (Ed.), *The State of Black America: 1991.* New York: National Urban League, Inc..

National Assessment Governing Board. (1991, September). *The Levels of Mathematics Achievement: Initial Performance Standards for the 1990 NAEP Mathematics Assessment.* Volume I, National and State Summaries, September.

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, Virginia: National Council for Teachers of Mathematics.

National Governors' Association and The Conference Board. (1987). *The Role of Science and Technology in Economic Competitiveness: Final Report.* Washington, DC: National Governors' Association.

National Research Council. (1989). *Everybody Counts: A Report to the Nation on the Future of Mathematics Education.* Washington, DC: National Academy Press.

National Science Board. (1991). *Science & Engineering Indicators - 1991.* Washington, DC: U.S. Government Printing Office. (NSB 91-1)

National Science Foundation. (1991, January). *Women and Minorities in Science and Engineering.* Washington, DC: National Science Foundation.

Oakes, J. (1990). *Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science.* Santa Monica, CA.: RAND.

Quality Education for Minorities Project. (1990, January). *Education That Works: An Action Plan for the Education of Minorities.* Cambridge, Massachusetts: Massachusetts Institute of Technology.

Ratteray, J. D. (1990). *Center Shift: An African-Centered Approach for the Multicultural Curriculum.* Washington, DC: Institute for Independent Education.

Ratteray, J. D. (1991, October). "Schools Make the Mark: Independent Neighborhood Schools Show Commitment to Excellent." *American Choices.* (A Report of the Institute for Independent Education, Inc.), *7*, (1).

Stills, P. (1989, December). "Dark Contagion: Bigotry and Violence Online." *PC Computing*, *2*, (12).

Triangle Coalition for Science and Technology Education. (1986). *How to Form and Operate a Local Alliance: A Handbook for Local Action to Improve Science and Technology Education.* Washington, DC: National Science Teachers Education.

WCCO, Channel 4, Minneapolis, Minnesota, 6:00 p.m. News Report, Wednesday, August 19, 1992.

Wilson, A. B. (1989). "Design and Results of a Pre-College Intervention: Interface Institute." In *Proceedings: Pre-College Education of Minorities in Science and Engineering*, New Jersey Institute of Technology, Newark, New Jersey: New Jersey Institute of Technology Press.